Paper No. 14

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte BERNARD M. KULWICKI[1]

Appeal No. 1997-3335
Application No. 08/315,454[2]

ON BRIEF

Before McKELVEY, *Senior Administrative Patent Judge* and WALTZ and TIMM, *Administrative Patent Judges*.

TIMM, *Administrative Patent Judge*.

DECISION ON APPEAL

This is a decision on appeal under 35 U.S.C. § 134 from an examiner's final rejection of claims 1-10, which are all of the claims pending in this application.

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[1]The real party in interest is Texas Instruments, Incorporated.

[2]Application for patent filed September 30, 1994.

BACKGROUND

Appellant's invention relates to a method of forming a dielectric film of barium and/or strontium titanate on a microelectronic device and a method of forming a capacitive structure. Claims 1 and 8 are illustrative:

1. A method of forming a barium and/or strontium titanate dielectric film on a microelectronic device, said method comprising:

(a) preparing a precursor solution by combining a boron compound, a titanium compound, and a precursor selected from the group consisting of barium compounds, strontium compounds, and combinations thereof, such that the molar ratio of boron to titanium in said precursor solution is between 0.001 and 0.1;

(b) depositing and densifying one or more layers of said precursor solution to form a precursor film on said device; and

(c) annealing said precursor film in an oxygen-containing atmosphere, thereby forming said dielectric film comprising substantially uniformly distributed first and second phases, said first phase containing a plurality of barium and/or strontium titanate grains and said second phase principally comprising boron oxide, whereby said boron in said precursor apparently lowers the processing temperature required to produce said titanate grains, and whereby boron additionally decreases the dielectric leakage current observed for said dielectric film.

8. A method of forming a capacitive structure on a microelectronic device, said capacitive structure having a dielectric laminate disposed between a first electrode and a second electrode, said method comprising:

(a) forming said first electrode on a substrate;

(b) depositing two or more precursor films over said first electrode, each of said films comprising titanium and at least one of barium and strontium, at least one of said films further comprising boron in a ratio to said titanium of at least 0.001;

(c) annealing said films at a temperature above 450 C in an oxygen-containing atmosphere, thereby forming said dielectric laminate comprising a plurality of grains with a perovskite crystal structure, each grain comprising titanium, oxygen, and at least one of barium and strontium, said dielectric laminate further comprising boundary regions between said grains, essentially all of said boron existing in said boundary regions as B_2O_3; and

(d) forming a second electrode over said dielectric laminate.

The prior art references of record relied upon by the Examiner in rejecting the appealed claims are:

Soong	4,379,854	Apr. 12, 1983
Bhargava et al. (Bhargava)	4,959,089	Sep. 25, 1990
Lipeles et al. (Lipeles)	4,963,390	Oct. 16, 1990
Takagi et al. (Takagi)	4,988,650	Jan. 29, 1991
Abe et al. (Abe)	5,292,694	Mar. 8, 1994
Kulwicki et al. (Kulwicki)	5,368,834	Nov. 29, 1994 (filed Aug. 13, 1993)
Kim et al. (Kim)	5,378,667	Jan. 3, 1995 (filed Dec. 10, 1993)

Claims 1-5 and 7 stand rejected under 35 U.S.C. § 103 as being unpatentable over Lipeles in combination with any one of Abe, Takagi, Bhargava or Soong. Claim 6 stands rejected under 35 U.S.C. § 103 as being unpatentable over the above mentioned prior art references and further in view of Kulwicki. Claims 8-10 stand rejected under 35 U.S.C. § 103 as being unpatentable over all of the above prior art references and still further in view of Kim. We reverse for the reasons that follow.

OPINION

We have reviewed the respective positions presented by Appellants and the Examiner. In so doing, we find ourselves in agreement with Appellants that the applied prior art fails to establish a *prima facie* case of obviousness of the claimed subject matter. Accordingly, we reverse the Examiner's rejection for essentially those reasons advanced by Appellants, and we add the following primarily for emphasis.

"A critical step in analyzing the patentability of claims pursuant to section 103(a) is casting the mind back to the time of invention, to consider the thinking of one of ordinary skill in the art, guided only by the prior art references and the then-accepted wisdom in the field." *In re Kotzab*, 217 F.3d 1365, 1369-70, 55 USPQ2d 1313, 1316-17 (Fed. Cir. 2000). "The invention must be viewed not with the blueprint drawn by the inventor, but in the state of the art that existed at the time." *In re Dembiczak*, 175 F.3d 994, 999, 50 USPQ2d 1614, 1617 (Fed. Cir. 1999)(quoting *Interconnect Planning Corp. v. Feil*, 774 F.2d 1132, 1138, 227 USPQ 543, 547 (Fed. Cir. 1985). To establish a *prima facie* case of obviousness, "there must be some teaching, suggestion or motivation in the prior art to make the specific combination that was made by the applicant." *In re Dance*, 160 F.3d 1339, 1343, 48 USPQ2d 1635, 1637 (Fed. Cir. 1998). "In other words, the examiner must show reasons that the skilled artisan, confronted with the same problems as the inventor and with no knowledge of the

claimed invention, would select the elements from the cited prior art references for combination in the manner claimed." *In re Rouffet*, 149 F.3d 1350, 1357, 47 USPQ2d 1453, 1458 (Fed.Cir. 1998).

Claim 1 recites a method of forming a barium and/or strontium titanate dielectric film on a microelectronic device. In essence, the process involves forming a precursor solution, depositing one or more layers of the solution on a microelectronic device, densifying the layers to form a precursor film and annealing the film in an oxygen-containing atmosphere. The precursor solution is formed by combining three ingredients; a boron compound, a titanium compound, and a precursor. The precursor can be a barium compound. The boron is required to be present in the precursor solution in a molar ratio of boron to titanium of 0.001 to 0.1.

The Examiner has applied a prior art reference, Lipeles, which teaches a metallo-organic solution deposition (MOSD) process for forming thick, transparent, crystalline films from ferroelectric oxides such as barium titanate, $BaTiO_3$ (col. 1, lines 14-21). The MOSD process includes steps of (a) combining metallo-organic starting materials to form a coating solution; (b) depositing the solution on a substrate by spin casting or dip coating, removing solvent by low temperature drying and drying/densifying by rapid heating at about 400°C to leave an amorphous film; and (c) after several layers are built up, annealing at about 535 to 800°C to form a crystallized oxide film (col. 2, lines 30-62). In order to make barium titanate, one of ordinary skill in the art would presumably combine a

barium compound starting material and a titanium compound starting material. Lipeles does not describe including a boron compound in the solution.

The Examiner turns to Abe, Takagi, Bhargava and Soong for the missing description of using boron compounds in dielectric films. The Examiner suggests that these references all teach that B_2O_3 or H_3BO_3 reduces the sintering temperature of the dielectric ceramic film $BaTiO_3$. The Examiner concludes that it would have been obvious for one of ordinary skill in the art at the time the invention was made to have modified the Lipeles metallo-organic film process with a boron additive as suggested by the secondary references to lower annealing temperatures, enable the use of lower cost electrode compositions and thus lower the cost of manufacturing (Answer, pages 5 and 6).

However, we are not convinced that Abe, Takagi, Bhargava or Soong would have led one of ordinary skill in the art to add a boron compound to the coating solution of Lipeles. Abe, Takagi, and Soong describe powder processing techniques for forming sintered ceramics. Bhargava is directed to a process of melting powders at 1300-1400°C to form a glass, placing the glass on a substrate and remelting and heating at 950 to 1050°C (col. 1, line 47 to col. 2, line 5). Appellants point out that the temperatures, homogeneity, and the reactions differ significantly between the solution process of Lipeles and the higher temperature powder and melt processes of the secondary references (Brief, page 16). The Examiner has provided no convincing rationale tending to show that one of ordinary skill in the art would have had a reasonable expectation that the boron compounds of the secondary references would

behave the same way in the solution process as they do in the powder and melt processes. From the evidence on the record, there is no basis to believe that one of ordinary skill in the art would have reasonably expected the boron compounds of the secondary references to reduce the 525-800°C annealing temperature of Lipeles in the same way the boron compounds reduce the firing temperatures of the powder processes. We note that the firing temperatures of Abe, Takagi and Soong are all above 800°C[3]. Absent from the applied prior art is the requisite suggestion or motivation for combining the applied reference teachings, based upon a reasonable expectation of success, in such a manner as to result in the Appellants' claimed subject matter. *In re O'Farrell*, 853 F.2d 894, 903-904, 7 USPQ2d 1673, 1680-1681 (Fed. Cir. 1988).

With respect to claim 1, we also note that Bhargava specifies using 18-32 mole % boron oxide and 18-32 mole % titanium oxide. Thus, the molar ratio of boron to titanium is 18:32 to 32:18 which converts to 0.56 to 1.8. Claim 1 requires a boron to titanium ratio of between 0.001 and 0.01. Even if there was a reason, suggestion or motivation to use the boron compound of Bhargava in the solution of Lipeles, one of ordinary skill in the art would have been led to use a much higher amount of boron than called for by claim 1.

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[3]Abe teaches firing at temperatures of 962°C or lower, preferably 900°C or lower (col. 5, lines 17-22) or around 900°C (col. 13, lines 39-42). Takagi describes firing at temperatures of 800 to 1350°C (col. 5, lines 24-27). Soong describes firing at temperatures of 2050°F, i.e. 1121°C (col. 2, lines 24-27).

Claim 1 also requires that the dielectric film formed comprise substantially uniformly distributed first and second phases. The first phase must contain a plurality of barium and/or strontium titanate grains and the second phase must principally comprise boron oxide. The Examiner reasons that the combination of references teaches identical precursors and similar temperature ranges and thus the perovskite film as recited and claimed would be inherently obtained (Answer, page 8). However, assuming one of ordinary skill in the art would combine the teachings of the references and use the boron compounds of the secondary references in the process of Lipeles, one of ordinary skill in the art would be required to perform experimentation to optimize the level of boron for reducing the annealing temperature. While it is possible that the result would be a first phase of barium titanate grains and a second phase of boron oxide, the phases being substantially uniformly distributed, it is not a certainty. "Inherency ... may not be established by probabilities or possibilities. The mere fact that a certain thing *may* result from a given set of circumstances is not sufficient." *Mehl/Biophile Int'l Corp. v. Milgraum*, 192 F.3d 1362, 1365, 52 USPQ2d 1303, 1305 (Fed. Cir. 1999). *See also Glaxo, Inc. v. Novopharm Ltd*., 830 F.Supp. 871, 874, 29 USPQ2d 1126, 1128 (E.D. N.C. 1993), *aff'd*, 34 USPQ2d 1565 (Fed. Cir.), *cert. denied*, 516 U.S. 988 (1995)("[I]t is not sufficient that a person following the disclosure sometimes obtain the result set forth in the claim, it must invariably happen.").

With respect to the other independent claim, claim 8, the Examiner adds Kulwicki and Kim to the rejection but does not indicate where, in any of the prior art references relied upon, a process is

taught including steps of forming an electrode on a substrate, depositing two or more precursor films over the electrode, annealing and forming a second electrode over the annealed laminate. Kim describes forming the dielectric ceramic and then forming the electrodes on both surfaces of the dielectric. The sequence of layer forming is different than that required by the process of claim 8.

We conclude that, on the present record, the Examiner has not established a *prima facie* case of obviousness with respect to claims 1-10. Therefore, we reverse.

OTHER ISSUES

We are unsure how "apparently" limits claim 1. Page 3 of the specification seems to indicate that the temperature requirements may or may not be reduced. We have not found it necessary to rely on the language of claim 1 reciting "whereby said boron in said precursor apparently lowers the processing temperature required to produce said titanate grains" as this language does not seem to further limit the method. "While it is not a requirement of patentability that an inventor correctly set forth, or even know, how or why the invention works, neither is the patent applicant relieved of the requirement of teaching how to achieve the claimed result, even if the theory of operation is not correctly explained or even understood." *Newman v. Quigg*, 877 F.2d 1575, 1581, 11 USPQ2d 1340, 1345 (Fed. Cir. 1989), *cert. denied*, 495 U.S. 932 (1990)(citations omitted). That being said, Appellant may wish to delete the theory from claim 1.

REVERSED

FRED E. McKELVEY Senior Administrative Patent Judge	)))))) BOARD OF PATENT
THOMAS A. WALTZ Administrative Patent Judge	) APPEALS) AND) INTERFERENCES
CATHERINE TIMM Administrative Patent Judge	))))

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APPEAL NO. 1997-3335 - JUDGE TIMM
APPLICATION NO. 08/315,454

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APJ McKELVEY

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DECISION: **REVERSED**

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DRAFT TYPED: 05 Feb 02

FINAL TYPED: